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# ESTRATÉGIA DE CONSERVAÇÃO DA BIODIVERSIDADE

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Título: THE ROLE OF BOTANIC GARDENS AND ARBORETA IN THE "EX SITU" CONSERVATION OF WILD PLANT RESOURCES

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# The role of botanic gardens and arboreta in the ex situ conservation of wild plant resources

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## INTRODUCTION

Although it is generally accepted that conservation of plant an animal species is best undertaken **in situ**, so that their populations can continue to evolve under natural conditions, such a solution is not always possible. For example, a very large number of species are now reduced to small populations whose survival in the medium to long term cannot be assured without habitat farming or some other form of intervention, as in the case of the majority of the endangered plant species on the island of Rodrigues, Nine of the species are reduced to less than ten individuals in the wild, three to single individuals (Strahm, 1989). Even then, there may be an appreciable risk that the remaining populations will not survive and, as Strahm points out, it is essential that both **in situ** and **ex situ** conservation work be carried out in tandem because the flora is so highly threatened. Any one approach on its own is doomed to failure.

There has been considerable reluctance on the part of the conservation community to admit the value of **ex situ** approaches to conservation, largely on the grounds that it is a poor substitute for maintaining populations in the wild. There is also a fear that widespread use of **ex situ** conservation might encourage the authorities to consider it a substitute for **in situ** and thereby put remaining natural areas of vegetation at risk. While there is clearly a risk that this argument could be advanced, it is incumbent on us to educate decicion-makers so that such facile judgements are not made.

What we advocate in the **Botanic Gardens Conservation Strategy** is the adoption of an **integrated approach** to conservation in the sense that the techniques to be applied should be the most appropriate to the particular circumstances (WWF/IUCN/BGCS 1989; Falk 1990). As Falk (1990) notes, the use of a wide range of conservation methods is compelled largely by the diversity in objects of conservation and threats they encounter. We have moved on from the earlier **laissez faire**

ethic that dominated conservation philosophy in earlier decades towards an acceptance of a much more interventionist approach on the one hand acceptance of the broader range of options and techniques for conservation that are now available to us on the other hand. We do not live in an ideal world and have to face the fact that few large areas of intact vegetation are likely to remain in the future, apart from those protected areas that we are able to maintain and manage effectively. Most conservation will have to be carried out, as now, is smaller, often fragmented pieces of vegetation or in secondary communities. In these fragments of vegetation the populations of plant species represented will inevitably be reduced in size, often to critical levels or facing imminent extinction, as in the examples cited above for Rodrigues. In such circumstances it would be foolhardy not to supplement **in situ** conservation measures with **ex situ** cultivation and multiplication as is currently being undertaken by several botanic gardens.

The use of **ex situ** methods, especially seed banking, for the conservation of germplasm of crop species, in the form cultivars and landraces, is now widespread and a major network of genebanks has been put in place around the world, notably by FAO, the CGIAR Crop Centres and IBPGR, and by national facilities such as those of the United States National Germplasm System, the Nordic Gene Bank, the Indian National Bureau of Plant Genetic Resources and the Vavilov Institute, Petrograd. The world's agricultural genebanks contain some 2.5 million accessions, most of which are of crop cultivars, with only small percentage referring to wild species. The U.S. Nationsl Germplasm system is the world's largest distributor of germplasm, supplying more than 130,000 samples from its collections each year to more than 100 nations (NRC 1991) and currently contains more than 380,000 different accessions of some 8,700 species.

Although many agricultural genebanks do contain accessions of wild species, the numbers and degree of sampling often inadequate, Moreover, unless there is some particular interest in these wild species accessions, as for examples, as crop relatives, there is no programme of activity carried out on them. In fact there is no overall world strategy for the conservation of genetic resources/germplasm of wild species, either **in situ** or **ex situ**. A major, largely unacknowledged role is played in this regard by the world's botanic gardens and arboreta and this paper will review what is being achieved by them and

will make proposals for consider improving the present system to make it more effective and comprehensive.

## THE BOTANIC GARDENS SYSTEM

There are curently about 1,500 botanic gardens and arboreta in the world. Details of their location and facilities may be obtained from the recently-publiched fifth edition of the International Directory of Botanical Gardens (Heywood et al. 1991). A majority of botanic gardens occur in temperate regions with relatively poor floras (Europe with a flora of about 11,500 species has a remarkable 540 botanic gardens) while the number of gardens in the tropics is small - for example, about 100 in Latin America which houses about 40% of the world's flora (c, 100,000 species). The range and variation of plant material that they contain is quite remarkable and represents the largest assemblage of plant diversity outside nature. Tens of thousands of species are represented in their collections although often by only one or a few individuals. Most of this material occurs exists as "living collections" (as opposed to seed) either in the open or in greenhouses (Heywood 1990, 1991a,b,c).

Until recently, most botanic garden collections were assembled for reasons other than conservation. In recent yeats many gardens have devoted efforts to building up conservation collections and today over 500 of them maintain such collections, mainly of native plant species, according to a recent survey undertaken in connection with the preparation of the **Botanic Gardens Conservation Strategy.** In most cases the sampling of wild populations has been inadequate and the numbers and conditions under which the material is grown do not meet present day standards for genetic resource conservation. For this reason, the Botanic Gardens Conservation Secretariat, which was established by IUCN in 1987 but is now a independent organization affiliated with IUCN, has as one of principal goals the formulation of procedures and methodologies for the sampling, collection, storage, documentation and maintenance for germplasm by botanic gardens and a set of guidelines is in preparation (Bramwell and Heywood, 1991).

The reasons for developing conservation collections in botanic gardens are various. They may be byproducts of taxonomic research or they may have no more scientific basis than the special interest of individual

members of the garden staff. Thus much material of conservation value in gaardens may have limited value in that no provision has been made for its long term preservation nor for its use as a source of material for possible reintroduction into the wild, if appropriate. Many botanic garden greenhouses contain so-called conservation collections whose value and future must be uncertain. This applies particularily to material of tropical species in gardens in temperate countries as is discussed below.

An increasing number of gardens are developing programmes for the conservation of locally or nationally endangered species with a view to their long-term conservation and, in an increasing number of cases, reintroduction to the wild. This involves research into methods of cultivation, propagation, seed storage and germination and close association with maagers of protected areas. Examples of such programmes may be found in participating gardens of the Center for Plant Conservation, St Louis, which aims to ensure the conservation of all the endangered species of the flora of North America. Other examples include the Jardin Botanico Canario Viera y Clavijo, Gran Canaria and various Australian botanic gardens such as Adelaide and Canberra. Several Chinese botanic gardens are engaged in the conservation of rare and endangered species, including medicional plants which are of major concern in China (He, Yuan, Qin and Dudley 1990; He and Cheng 1991)). Indeed conservation of medicinal plants is undertaken by a large number of botanic gardens in different parts of the world and is reviewed by Heywood (1991d) who also gives a list of the gardens concerned.

## PLAN OF ACTION

It is quite clear that if their infrastructure and technical facilities can be strengthened, the world's botanic gardens can be developed as the main conservation network for wild species. They have the capacity to conserve **ex situ** adequate samples of the majority of the currently endangered species of the world. These are of the order of 40,000, a figure which is arrived at by taking the number of species that are recorded by the Threatened Plants Database of the World Conservation Monitoring Centre as Endangered, Vulnerable or Rare and multiplying it by two to allow for under-representation of tropical species.

If we take this figure of 40,000 species that require conservation action, and if we concentrate initially on the 20,000 about which we have information as to their status, we can attempt to calculate the costs of their **ex situ** conservation. The costs per species sample will vary according to whther they are annuals, biennals, perennials or trees, their breeding system, and whether they are conserved in seed banks under conditions of desiccation and refrigeration, in field genebanks, or in vitro as tissue or cell culture. Also the capital costs if included will vary considerably. If we accept an average figure of $1,000-2,000 per species per annum, the total annual costs will be of the order of $ 20-40 million. While this is a substantial sum to be found annually, it is remarkably low in comparison with other kinds of expenditure such as defence and is one or more orders of magnitude lower than the costs of conserving a similar number of animals.

## PRIORITY SPECIES

While such a target is attainable, it is unlikely to be achieved, for a whole series of technical and political reasons, and we must try and establish priorities within the 20,000 candidate species. In the **Botanic Gardens Conservation Strategy** it is proposed that attention should be focussed on:

economically important species
species required for reintroduction
keystone species
taxonomically isolated species
primitive cultivars
semi-domesticated species

In deciding on priorities, close liaison should be maintained with other agencies such as IBPGR and FAO, national and regional genebanks, forest organizations, conservation bodies and so on. A great deal of technical expertise has been acquired during the past two decades in the conservation of crop and forestry species and clearly full advantage should be taken of this by botanic gardens. Of course there are major differences in practice between the conservation of germplasm for plant breeding by the various crop genebanks and the conservation of samples of species as part of an overall strategy for their survival and potential reintroduction into the wild or reinforcement of endangered wild populations. In the former, the bulk of the accessions are of cultivars and only a small minority of wild relatives. Most of the accessions in crop seedbanks consist of several thousand seeds and characterization and evaluation of the material is an important part of the whole operation, even though it is not always achieved. In the case seeds which are recalcitrant, the material is kept as in field genebanks, as clonal collections, in tissue or cell culture or, in a very few cases, under cryopreservation.

Botanic garden conservation is concerned with a much larger number of species and fewer accessions of each. Much more effort is placed on understanding the reproductive biology and cultural requirements of species that are candidates for reintroduction or for introduction into cultivation as in the case of medicinals plantas and other locally valuable plants.

## GEOGRAPHICAL CONSIDERATIONS

Although botanic gardens in temperate regions such as Europe and North Americal have in general, as we have seen, better support, facilities and staffing, and are often more vociferous about their plant conservation activities than many of those in areas rich in plant diversity with tropical or subtropical climates, it is to the latter that we must look to play a major role in plant germplasm in the future. The emphasis will be more on wild species of economic importance such as underexploited fruit trees, vegetables, rootcrops, oils, fibre plants, and medicinal plants. Also important will be species of ornamental importance such as orchids, succulents, bromeliads and the like which too have an economic importance. For

botanic gardens in the tropics this will not be a new departure but a role that many of them fulfilled with conspicuous success in the 19th century (Heywood 1983; Smith 1986). What we have to face however is the fact that there are far too few botanic gardens in the tropics to cope with the conservation of the large number of species at risk and that many of those that do exist have inadqueate support or facilities. Even more disconcerting is the fact that the largest conservation collections fo tropical plants in cultivation are to be found in the greenhouses of botanic gardens in temperate countries. It seems inevitable that as a matter of policy, consideration should be given to repatriating many of these collections (or at least duplicate material of them) to their countries of origin where new botanic gardens should be created when necessary. These new gardems need not in many (?most) cases have the whole spectrum of facilities of modern western botanic gardens but should have the minimum facilities needed to cultivate, propagate, bulk up and undertake research on the basic biology and reproduction of local endangered species. It is in these tropical botanic gardens that the necessary conservation activities of tropical species can be effectively undertaken, not in temperate countries. While this may seem obvious, the current disposition of conservation collections and resources suggests otherwise!

Also protected areas in the tropics should have associated with them such minimum facility botanic gardens so that integrated conservation on endangered species can be carried out. An important role for northern/temperate gardens will be the support of these tropical gardens, with technology transfer, staff training etc.

An overal conservation strategy for wild species germplasm needs to be developed and the basic elements are given in the Biodiversity Conservation Strategy and Action Plan (chapter VI Actions 15a-f-16).

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